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A Coded Wire Tag Assessment of Salmon River (Langley) Coho Salmon: 1987 Tag Application and 1988-89 Spawner Enumeration

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by

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ABSTRACT

Kalnin, L.W. and N.D. Schubert. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1987 tag application and 1988-89 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2068: 37p.

In 1986, the Department of Fisheries and Oceans began implementation of a plan to improve the assessment data for coho salmon (**Oncorhynchus kisutch**) through the long term evaluation of key stocks. The Salmon River (Langley) was selected for the evaluation, with known precision, of annual escapement, marine survival, harvest distribution and exploitation rate. An estimated 20,022 (corrected for long term coded wire tag (CWT) loss) coho smolts were released with CWTs in the spring of 1987 at an average size of 95.6 mm and 9.6 g. The adult escapement was estimated in the fall/winter of 1988-89 using the Petersen mark-recapture method. Escapement was estimated at 9,152, of which 1,138 had CWTs and 178 (13.5%) had lost the CWT. Survival to escapement of 1985 brood Salmon River coho was 5.4%.

Key Words: Coho salmon, Salmon River (Langley), key stream, coded wire tag, escapement, survival.

RÉSUMÉ

Schubert, N.D. and L.W. Kalnin. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1987 tag application and 1988-89 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2068: 37p.

En 1986, le ministère des Pêches et Océans a entrepris une évaluation à long terme des stocks clés pour améliorer la base de données sur le saumon coho (**Oncorhynchus kisutch**). Il a choisi de faire cette évaluation dans la rivière Salmon (Langley) et d'établir des données précises sur l'échappée annuelle, la survie, la répartition des captures et le taux d'exploitation. Au printemps de 1987, environ 20 022 (chiffre ajusté pour tenir compte des pertes à long terme de micromarques magnétisées codées) jeunes saumons mesurant en moyenne 95,6 mm, pesant en moyenne 9,6 g, et pourvus d'une micromarque magnétisée codée ont été relâchés. L'échappée des adultes a été estimée à l'automne et au printemps de 1988-89 au moyen de la technique Petersen de marquage-recapture. L'échappée a été estimée à 9 152 poissons, dont 1 138 avaient encore leur micromarque et 178 (13,5%) l'avaient perdue. La survie à l'échappée des cohos géniteurs de 1985 de la rivière Salmon était de 5,4%.

Mots clés: Saumon coho, rivière Salmon (Langley), cours d'eau important, micromarque magnétisée codée, échappée, survie.

INTRODUCTION

Coho salmon (Oncorhynchus kisutch) are among the most difficult salmon species to study, due both to the mixed stock nature of their marine distribution and to spawner characteristics which make escapement estimation difficult (Anon. 1969, 1984). A lack of reliable assessment data has inhibited the development of sophisticated approaches to the management of coho salmon in British Columbia. Improved stock assessment information, an important prerequisite for active management, is required to define current stock status and to evaluate future management actions.

Improved assessment of British Columbia coho salmon will result from the intensive monitoring of a group of key stocks selected to represent all British Columbia coho stocks. The status and response to management actions of these stocks will be evaluated by measuring, with known precision, annual escapements, marine survivals, harvest distributions and exploitation rates.

The Salmon River was designated a key stream in 1986 for three reasons. First, recent escapements of Salmon River coho comprised 4% of the Fraser River total (Farwell et al. 1987). The status of this stock, therefore, is an important measure of the status of the Fraser River coho resource. Second, similar data collected from the 1976-78 brood years (Schubert 1982a; Schubert and Fleming 1989) provide a time series of comparable data. Third, simplified logistics limited project costs.

A previous report documented the evaluation of 1984 brood Salmon River coho salmon (Schubert and Kalnin 1990). The current report documents, for the 1985 brood, the 1987 coho smolt trapping and coded wire tag (CWT) application and 1988-89 coho adult escapement estimation studies. The report describes field methodologies, analytic techniques and study results, including smolt timing, age and size and adult age, length, sex, adipose fin clip (AFC) incidence and estimates of escapement and long term CWT loss. The study did not estimate the escapement of precocious males (jacks). The report concludes with a discussion of data limitations and recommendations for future studies.

STUDY AREA

The Salmon River flows northwest for 33 km, entering the Fraser River west of Fort Langley (Fig. 1). Coghlan Creek, the principal tributary, joins the mainstem 14 km upstream from the Fraser River. The system, with an average daily discharge of 1.41 m^3/s (Environment Canada 1986), drains 85 km^2 of lowland agricultural and residential land. In the upper reaches, the river is marshy with low summer flows. In the middle reaches, the river flows across low gradient terrain in a shaded, meandering channel. In the lower 10 km, the river is slow and deep as it flows in a series of tortuous meanders across meadowland. During the Fraser River spring freshet, the Salmon River passes through a pumphouse located at the river mouth. No provisions were made for fish passage. Up to 31% of the coho smolts are killed when they pass through the pumps (Russell MS 1981).

The Salmon River supports several anadromous and freshwater species, with coho salmon dominant (Hartman 1968; DeLeeuw MS 1981; Schubert 1982a). Coho adults enter the river at ages 3_2 and 4_3 and spawn in the middle and upper reaches from November to January (Schubert 1982b; Schubert and Fleming 1989). Coho escapements averaged 3,000 and 2,400 in

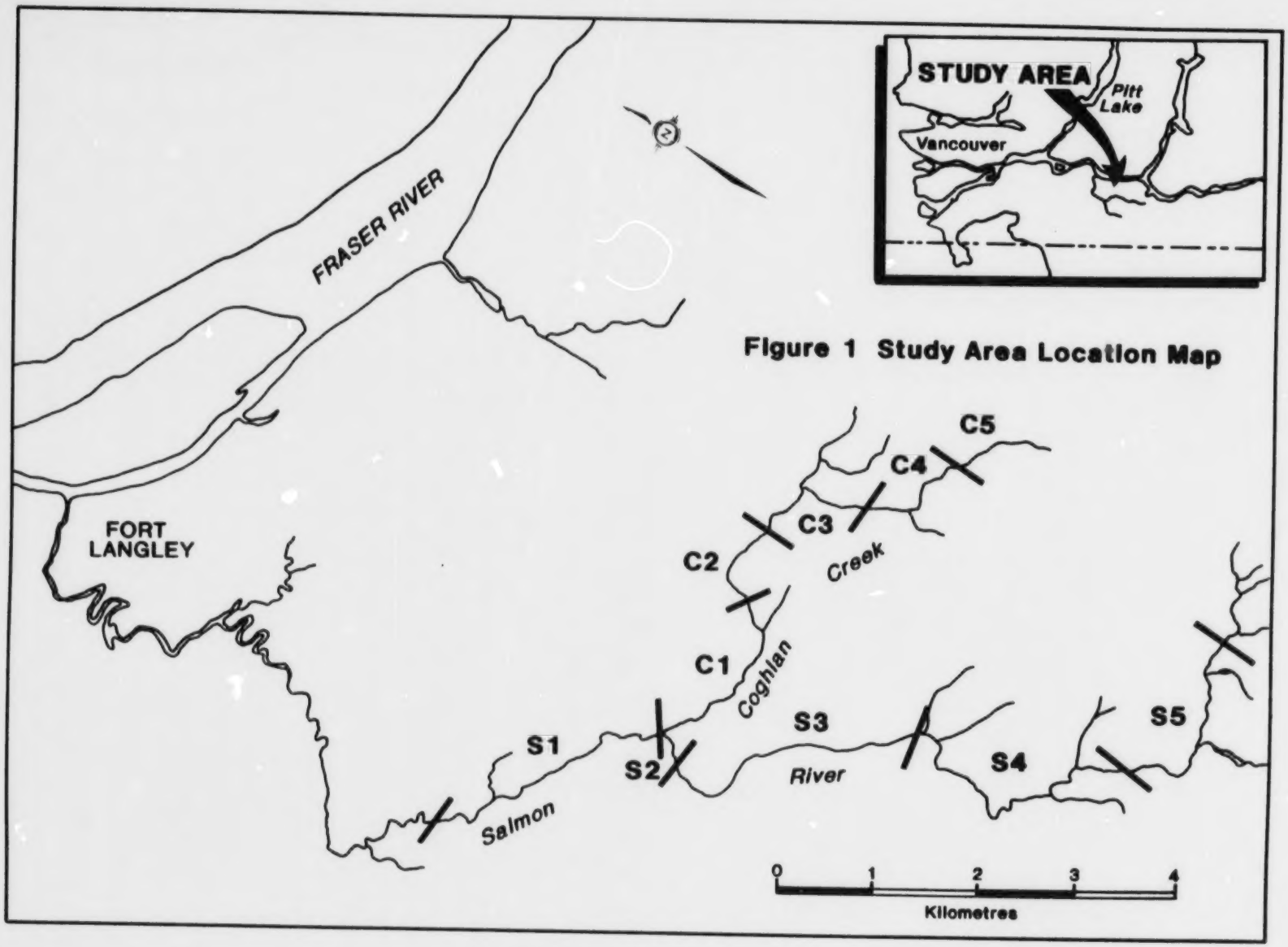

Figure 1 Study Area Location Map

1970-79 and 1980-86, respectively (Farwell et al. 1987).

METHODS

JUVENILE PROGRAM

Fish Capture

Fence traps similar to those described by Schubert (1982a) were operated in Coghlan Creek from April 22 to May 30, 1987 and in the Salmon River from April 23 to May 30, 1987. The Coghlan Creek trap was located 100 m above the Salmon River. The Salmon River trap was located 75 m above the Coghlan Creek confluence.

Captured fish were sorted by species and enumerated at least once daily. Coho smolts were transferred to holding boxes or to the tagging site for tagging and sampling. Coho fry were not enumerated because the 6 mm fence mesh did not fully restrict their passage. The remaining catch was identified to species and released below the trap. Trout were enumerated by species and recorded as smolt or presmolt, based on size and parr marks. Smolts were defined as those fish with a silver coloration and with a nose-fork (NF) length generally greater than 11 cm. Presmolts were defined as those fish with distinct parr marks and with a NF length less than 11 cm. Recently emergent trout fry were not enumerated.

Coded Wire Tagging

The CWT equipment and maintenance procedures were described by Armstrong and Argue (1977). Coded wire tagging occurred from April 24 to May 29, 1987 at intervals of one to four days. On each day, the smolts were sorted by size (NF length of less than 75 mm, between 76 and 100 mm, or greater than 100 mm) and separate nose molds and implant depths were used for each group. Implant depth was checked for each group by bisecting the skull of a coded wire tagged smolt along the median plane. If the CWT was not in the preferred position in the cartilaginous wedge of the skull, the implant depth was adjusted and the procedure repeated until CWT placement was correct. Once correct placement was determined, the nose mold was marked to permit proper implant depth when molds were changed. The smolts were anesthetized with Tricaine Methane Sulfonate (TMS), marked by adipose fin removal, coded wire tagged and passed through a quality control device to ensure the CWT was present. Any diseased, damaged or undersized (less than 55 mm NF length) smolts were released untagged. A representative sample of approximately 200 was removed from the recovery bucket each day and retained for 24 hour assessment of AFC quality, delayed mortality and CWT loss. Any coho without a CWT or with a poor AFC was retagged or reclipped. All other smolts were either transported that day or held until morning if temperatures were not suitable for transport.

Transport

Coded wire tagged smolts were released at the Salmon River mouth to avoid pump related mortality. The smolts were transported in a 390 litre holding tank supplied with air from a twelve volt air pump. Transport required less than fifteen minutes.

Sampling

Fifty coho smolts per site were sampled twice weekly for scales, length and weight. The smolts were anesthetized with TMS, a scale smear

was removed with a scalpel from each preferred region, NF length was measured to the nearest millimeter and mean wet weight (±0.1 g) was determined in aggregate on an Ohaus triple beam balance.

ADULT PROGRAM

Fish Capture

Coho adults were captured twice per week in reaches S1 to S5 and C1, C3 and C5 (Fig. 1) from November 2, 1988 to January 6, 1989. Coho were attracted from log jams and cut banks with an electroshocker using direct current. Voltage (600 volts) and frequency (15 to 30 milliseconds) were adjusted daily to ensure the fish were undamaged, but stunned sufficiently to permit capture. Stunned coho were captured in a dip net, permitted to recover in a 60 l container of water, disk tagged and released.

Disk Tag Application

Coho adults were Petersen disk tagged in a wooden tray (10 cm x 10 cm x 100 cm) constructed with a flexible plastic bottom and a meter stick recessed in one side. The tags consisted of two 2.2 cm diameter laminated cellulose acetate disks and one 0.7 cm diameter transparent plastic buffer disk threaded through centrally punched holes onto a 7.7 cm long nickel pin. The pin was inserted with pliers through the musculature and pterygiophore bones approximately 1.2 cm below the anterior portion of the dorsal fin insertion. The disk tags, arranged with one on each side of the fish and with a buffer disk on the pin head side, were secured by twisting the pin into a double knot. One disk per pair was numbered with a unique code. Initially, green and blue disk tags were used to reduce colour contrast, thereby minimizing recovery and predation biases; however, yellow disk tags and baffles were used in the latter part of the study.

Each disk tagged fish received a secondary mark to allow the assessment of disk tag loss. A 0.7 cm diameter hole was punched through the operculum using a single hole paper punch. Care was taken to avoid gill tissue damage.

Date and location (reach) of capture, disk tag number, NF length (to the nearest 0.1 cm), sex and adipose fin status were recorded for each fish released with a disk tag. Release condition was recorded as 1 (swam away vigorously), 2 (swam away sluggishly) or 3 (required ventilation). Recovered disk tagged carcasses were enumerated and sampled (described below) to assess handling mortality.

Stream Surveys

Weekly stream surveys were conducted from November 10, 1988 to January 27, 1989. Complete surveys, conducted by a three or four person crew, required up to two days.

Live adults were counted and carcasses were recorded by date, reach, sex (confirmed by abdominal incision) and mark type (disk tag, secondary mark or AFC). Each marked carcass and every tenth unmarked carcass was sampled. All carcasses were then cut in two with a machete and returned to the river. Sample data, recorded by date and reach, included postorbital-hypural plate (POH) length (to the nearest 0.1 cm), sex, female spawning success (0%, 50% or 100% spawned), adipose fin and carcass condition, and scale samples. For AFC coho, the head was removed posterior to the eye orbit for later CWT identification. Adipose fin

condition was recorded as unclipped or as complete (flush with dorsal surface), partial (nub present) or questionable (appeared clipped but fungus or decomposition obscured area). The condition of AFC carcasses was recorded as fresh (gills red or mottled), moderately fresh (gills white, body firm), moderately rotten (body intact, flesh soft) or rotten (skin and bones), and the absence of one or both eyes was noted.

Escapement Estimation

Total Escapement: The 1988-89 escapement of Salmon River coho adults was calculated from the mark-recapture data using the Petersen formula (Chapman modification) (Ricker 1975). Total escapement was the sum of escapement by sex:

1) Estimated Salmon River system coho escapement (N_t):

$$N_t = N_m + N_f$$

where:

N_m = estimated escapement of adult males

$$= \frac{(M_m + 1)(C_m + 1)}{(R_m + 1)}$$

N_f = estimated escapement of females, analogous to above.

2) Estimated 95% confidence limits of N_t:

$$N_t \pm 1.96\sqrt{V_t}$$

where:

N_t = total escapement estimate;

V_t = variance of the escapement estimate;

$= V_m + V_f$

V_m = variance of the adult male escapement estimate;

$$= \frac{(N_m^2)\ (C_m - R_m)}{(C_m + 1)\ (R_m + 2)}$$

N_m = adult male escapement estimate;

C_m = number of adult male carcasses examined for disk tags;

R_m = number of disk tagged or secondary marked adult males recovered;

V_f = variance of female escapement estimate, analogous to above.

Sex Identification Correction: The disk tag application data were corrected for sex identification error. Error occurred because the development of sexually dimorphic traits was often not advanced and internal examinations could not be made. Correction of recovery data was unnecessary because all carcasses were incised and examined internally. Sex identification error was corrected as described by Staley (1990):

3) Estimated true number of males released with disk tags and secondary marks (M_m):

$$M_m = \frac{M^*_m - (M_t R_{m,f})/R_f}{1 - (R_{m,f}/R_f) - (R_{f,m}/R_m)}$$

where:

M^*_m = field estimate of number of males released with disk tags and secondary marks;

M_t = total number of coho adults released with disk tags and secondary marks;

$R_{m,f}$ = number of females recovered with disk tags which were released as males;

$R_{f,m}$ = number of males recovered with disk tags which were released as females;

R_f = number of females recovered with disk tags;

R_m = number of males recovered with disk tags.

4) Estimated true number of females released with disk tags and secondary marks (M_f):

$$M_f = M_t - M_m$$

Adipose Fin Clipped Escapement: The estimated AFC escapement was the product of the AFC incidence in the carcass recovery sample, the largest of the two available samples, and the mark-recapture escapement estimate. Ninety-five percent confidence limits were calculated from the respective upper and lower confidence limits of the AFC incidence and the escapement estimate. For example, the upper 95% confidence limit of the AFC escapement estimate was the product of the upper limit of the AFC incidence and the upper limit of the total mark-recapture estimate. The mathematical relationships are reported below (Cochran 1977):

5) Estimated AFC escapement (N_a):

$$N_a = p(N_t)$$

6) Estimated 95% confidence limits for p:

$$p \pm 1.96 (se + fpc)$$

where:

p = proportion of the sample with an AFC;

se = standard error;

$$= \sqrt{(1-f)pq/(n-1)}$$

fpc = finite population correction;

$$= \frac{1}{2n}$$

n = sample size;

q = 1-p

$$f = \frac{n}{N_t}$$

Coded Wire Tagged Escapement: Escapement by CWT code and long term CWT loss were calculated by applying the CWT incidence in the carcass recovery sample to the estimated return of AFC coho adults. Apparent CWT loss was adjusted for carcass condition and predator activity, when appropriate.

RESULTS

JUVENILE PROGRAM

Fish Capture

Coho smolt catch totaled 24,048 in 1987, 15,572 in the Salmon River and 8,476 in Coghlan Creek (Appendix 1). The smolt migration began before trap installation on April 22 and continued through early June. The 50% migration occurred on May 6 and May 7 in the Salmon River and Coghlan Creek, respectively, while the peak catches occurred on April 30 and May 8 (Figs. 2 and 3). Because the traps were inoperable for three days in May and some smolts were lost due to vandalism, the true size and timing of the 1987 smolt emigration were unknown.

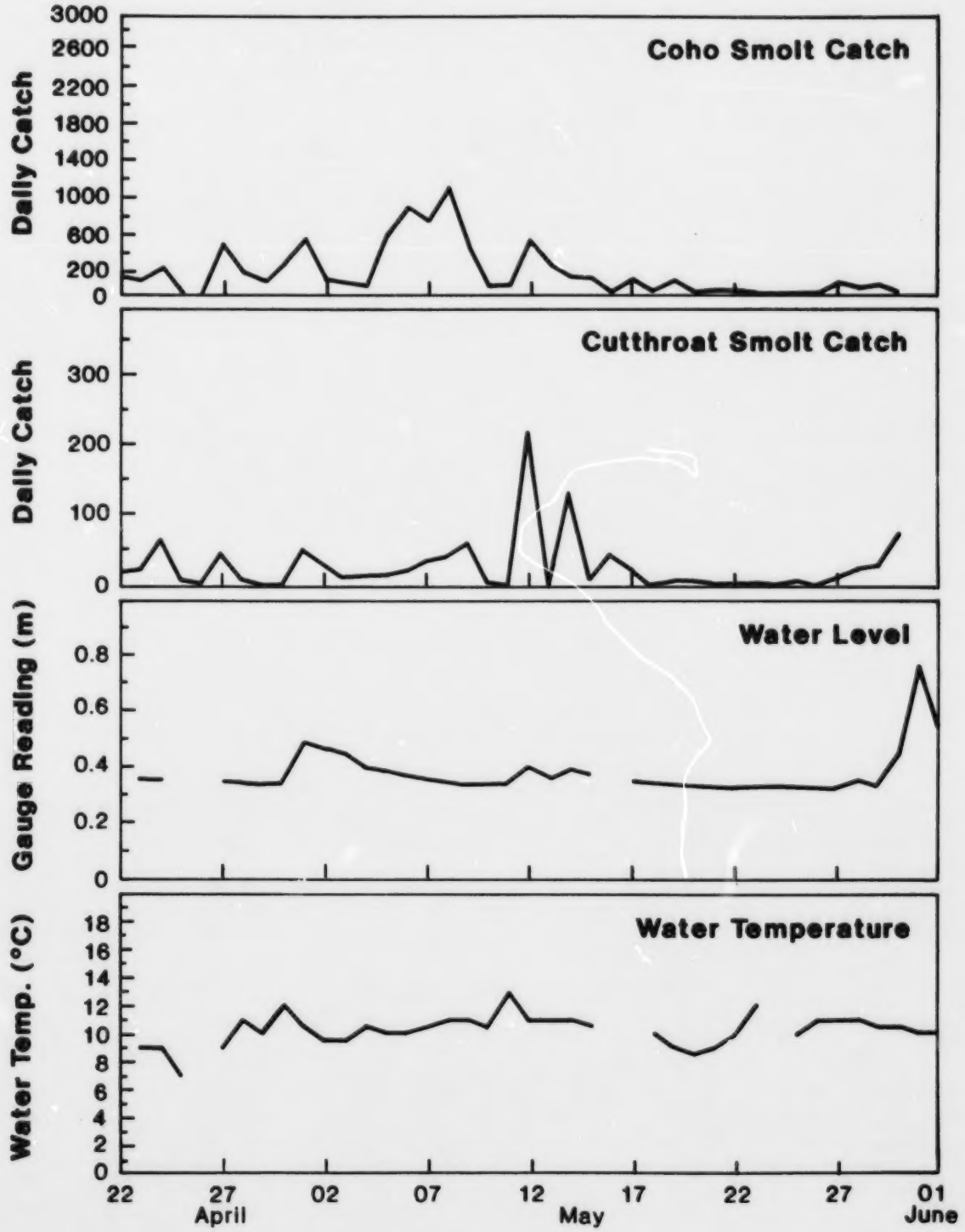

Figure 2 Daily catch of Coghlan Creek coho and trout smolts in relation to water level and temperature, 1987

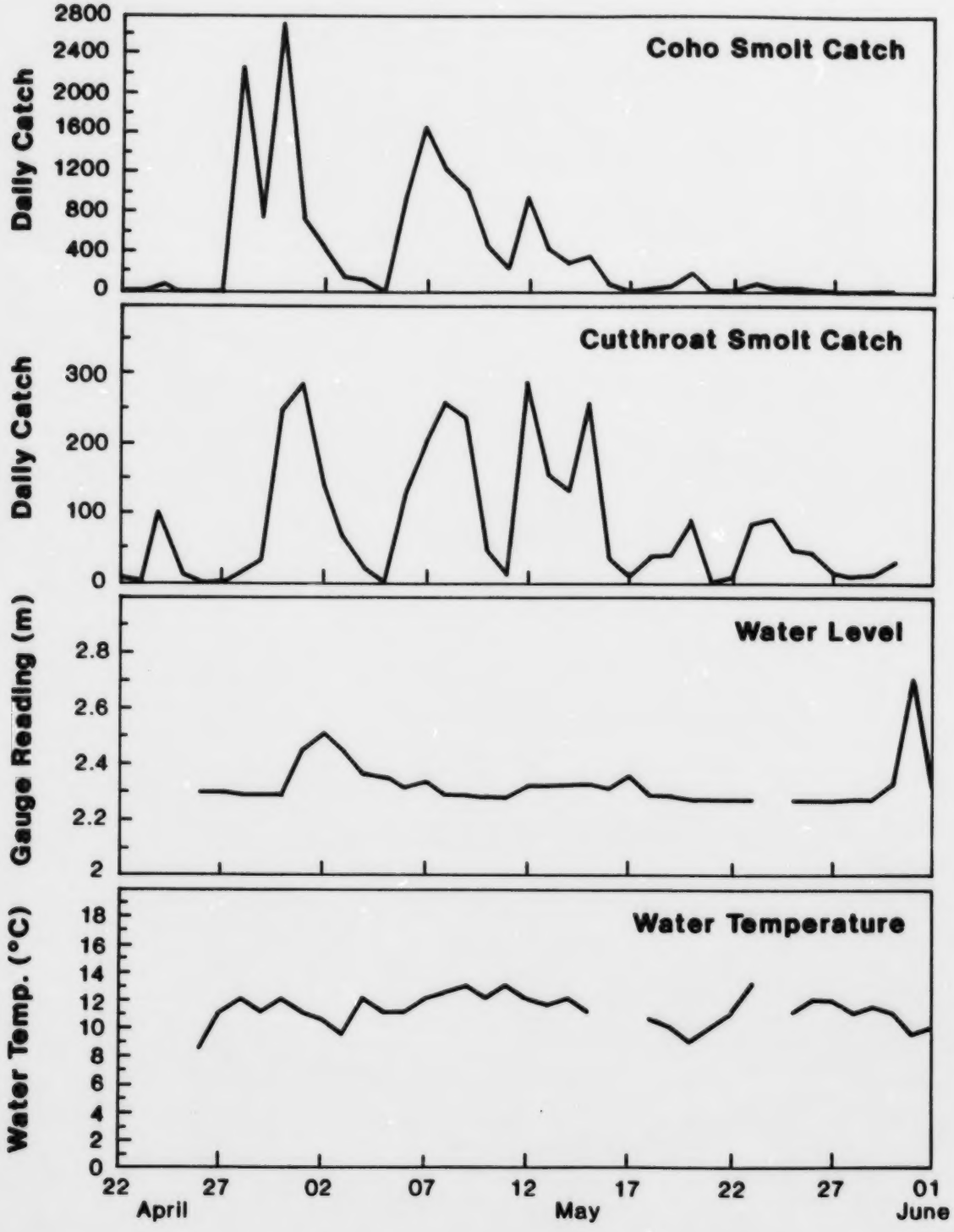

Figure 3 Daily catch of Salmon River coho and trout smolts in relation to water level and temperature, 1987

Coded Wire Tagging

AFC and CWT releases totaled 23,321 coho smolts in 1987 (Appendix 2). When adjusted for long term CWT loss and short term mortality, the number released with CWTs and identifiable AFCs was 20,022.

Short and long term CWT loss averaged 0.9% (range of 0% to 4.9%) and 13.5%, respectively. The incidence of poor AFCs and delayed mortality both averaged less than 0.1%. The incidence of disease, damage or structural anomalies averaged 6.8% (Appendix 3). The most prevalent condition was fog eye, a reversible stress induced opaque clouding of the eye. This condition was most prevalent in the Salmon River where 6.8% of the coho smolts were affected. No smolts with naturally missing adipose fins were noted.

Coho Smolt Age and Size

Coho smolts emigrated from the Salmon River system primarily as yearling (age 1+) smolts (99.2%), with age 2+ smolts forming the remainder of the run. Smolt size averaged 97.0 mm and 10.0 g in the Salmon River and 93.1 mm and 9.0 g in Coghlan Creek (Appendix 4). Weighted mean smolt size was 95.6 mm and 9.6 g. Smolt size decreased through the run (Appendix 4).

ADULT PROGRAM

Mark-Recapture

Disk Tag Application: Seven hundred and seventeen coho adults were released with disk tags and secondary marks from November 2, 1988 to January 6, 1989 (Table 1; Appendix 5). Of that total, 174 had AFCs. Condition at release was good, except 9 (1.3%) required ventilation (Table 2). No difference ($p > 0.05$; chi-square) was noted in the proportion of this group recovered on the spawning grounds.

An estimated 8.3% of the males and 10.2% of the females were misidentified at the time of tagging (Appendix 6). When adjusted for sex identification error, an estimated 284 (39.6%) males and 433 (60.4%) females were released with disk tags and secondary marks.

Spawning Ground Recovery: One thousand, three hundred and seventy-seven coho adults and 9 jacks were recovered on the spawning grounds from November 10, 1988 to January 27, 1989 (Table 1; Appendix 7). Of the adults, 579 (42.0%) were male and 798 (58.0%) female, 107 (7.8%) had disk tags and secondary marks and 198 (14.4%) had an AFC. One (11.1%) of the jacks had an AFC. None of the coho adults had lost a disk tag or a secondary mark.

Sampling Selectivity

Period: Temporal bias in the application sample was examined by comparing between periods the mark incidence in the recovery sample (Table 3). No significant difference ($p > 0.05$; chi-square) was noted in total or for females; however, a significant difference ($p < 0.05$; chi-square) was noted for males.

Recovery bias was examined by stratifying the application sample by period and comparing proportions recovered (Table 4). No significant difference ($p > 0.05$) was noted between periods.

Location: Spatial bias in the application sample was examined by comparing between sections the mark incidence in the recovery sample (Table 5). Mark incidence, ranging

Table 1. Disk tag application, carcass examination and mark recovery by sex of Salmon River system coho adults, 1988-89.

	Disk tags applied	Carcasses examined[b]	Marked carcasses recovered[b]: Disk tag and secondary mark	Secondary mark only	Disk tag only	Total	Percent recovered
Male	284[a]	579	48	0	0	48	16.9%
Female	433[a]	798	59	0	0	59	13.6%
Adipose present	543	1,179	82	0	0	82	15.1%
Adipose absent	174	198	25	0	0	25	14.4%
Total	717	1,377	107	0	0	107	14.9%

[a] Adjusted for sex identification errors.
[b] Jacks excluded.

Table 2. Disk tag application and recovery of Salmon River system coho adults, by release condition, 1988-89.

Release condition	Disk tags applied[a]	Disk tags recovered[a]	Percent recovered
Fish swam away without assistance	707	105	14.9%
Fish required ventilation	9	1	11.1%
Total	717	107	14.9%

[a] Release condition was not recorded for one female.

Table 3. Incidence of disk tags or secondary marks in coho adults recovered on the Salmon River system spawning grounds, by period and sex, 1988-89.

Recovery period	Recovered with disk tag or secondary mark			Total			Percent with disk tag or secondary mark		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
02-Nov to 29-Nov	11	6	17	47	74	121	23.4%	8.1%	14.0%
30-Nov to 27-Dec	19	29	48	226	314	540	8.4%	9.2%	8.9%
28-Dec to 27-Jan	18	24	42	306	410	716	5.9%	5.9%	5.9%
Total	48	59	107	579	798	1,377	8.3%	7.4%	7.8%

Table 4. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application period and sex, 1988-89.

Application Period	Disk tags applied[a]			Disk tags or secondary marks recovered			Percent recovered		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
02-Nov to 22-Nov	210	308	518	31	36	67	14.8%	11.7%	12.9%
23-Nov to 13-Dec	38	77	115	11	14	25	28.9%	18.2%	21.7%
14-Dec to 06-Jan	36	48	84	6	9	15	16.7%	18.8%	17.9%
Total	284	433	717	48	59	107	16.9%	13.6%	14.9%

[a] Adjusted for sex identification error.

from 1.2% to 27.0%, was significantly different ($p < 0.05$) than that expected. Mark incidence was highest in the lower Salmon River and lowest in upper Salmon River and upper Coghlan Creek.

Recovery bias was examined by stratifying the application sample by section and comparing proportions recovered (Table 6). No difference ($p > 0.05$) was noted.

Fish Size: Size related bias in the application sample was assessed by comparing the continuous POH length frequency distributions of marked and unmarked spawning ground recoveries. No significant difference was noted in males or females ($p > 0.05$; Kolmogorov-Smirnov two sample test) (Sokal and Rohlf 1981). The application sample, therefore, was unbiased with respect to size.

Recovery bias was assessed by partitioning the application sample into recovered and nonrecovered components and comparing the continuous NF length frequency distributions of each. Although the proportion recovered was highest in the largest size group (Table 7), no significant difference was noted in males or females ($p > 0.05$). The recovery sample, therefore, was unbiased with respect to size.

Fish Sex: Sex related bias in the application sample was assessed by comparing the sex ratio of the marked and unmarked spawning ground recoveries (Table 8). No significant difference was noted ($p > 0.05$; chi square).

Recovery bias was assessed by partitioning the application sample into recovered and nonrecovered components and comparing the sex ratio in each (Table 8). No significant difference was noted ($p > 0.05$; chi-square). Furthermore, no significant difference was noted in the proportion of males (16.9%) and females (13.6%) released with disk tags and recovered on the spawning grounds (Table 1).

Spawning Success: Spawning success, estimated from internal examination of female spawning ground recoveries, was 93.4% (Appendix 8). Spawning success of disk tagged (85.0%) and untagged (96.1%) females was significantly different ($p < 0.05$; difference in proportions test) (Dixon and Massey 1969).

Estimation of Spawner Population

Total Escapement: The 1988-89 escapement of Salmon River coho adults, calculated from mark-recapture data, was 9,152 (Table 9). Upper and lower 95% confidence limits were 10,746 and 7,560, respectively. The escapement of female and male coho adults was 5,779 and 3,373, respectively.

Adipose Fin Clipped Adults: Based on the AFC incidence in the spawning ground sample (14.4%) (Table 1), the 1988-89 escapement of AFC adults was 1,316, with upper and lower 95% confidence limits of 1,479 and 1,153, respectively (Table 9). Of that total, an estimated 1,138 returned with a CWT and 178 (13.5%) had lost the CWT (Table 10; Appendix 9). CWT loss was not influenced by carcass decomposition or predation (Appendix 10). Of those which returned with CWTs, 1,082 were 1985 brood Salmon River coho, 54 were 1984 brood Salmon River coho and 1 was a 1985 brood Legace Creek coho (code 02 39 50). The latter was treated as a rare event and was not expanded.

Table 5. Incidence of disk tags and secondary marks, by section, in the Salmon River system spawning ground recovery sample, 1988-89.

Location	Section[a]	Carcasses examined[b]		Carcasses recovered with disk tags or secondary marks	
		Number	Percent of total	Number	Mark Incidence
Salmon River	Lower	159	11.5%	43	27.0%
	Middle	141	10.2%	18	12.8%
	Upper	390	28.3%	16	4.1%
Coghlan Creek	Lower	187	13.6%	24	12.8%
	Upper	500	36.3%	6	1.2%
Total	-	1,377	-	107	7.8%

[a] Salmon River: lower - S1 and S2; middle - S3; upper - S4 and S5.
Coghlan Creek: lower - C1; upper - C2, C3, C4 and C5.
[b] Jacks excluded.

Table 6. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application section, 1988-89.

Location	Section[a]	Disk tags applied		Disk tags recovered	
		Number	Percent of total	Number	Percent recovered
Salmon River	Lower	327	45.6%	45	13.8%
	Middle	52	7.3%	6	11.5%
	Upper	216	27.9%	36	17.0%
Coghlan Creek	Lower	105	14.6%	15	14.3%
	Upper	17	2.4%	5	29.4%
Total	-	717	-	107	14.9%

[a] See Table 5 for section descriptions.

Table 7. Disk tag application and recovery of Salmon River system coho adults, by nose-fork length, 1988-89.

Nose-fork length (cm)	Disk tags applied [a]	Carcasses recovered with disk tags [b]	Percent recovered
31-40	33	2	6.1%
41-50	292	48	16.4%
51-60	352	42	11.9%
61-70	37	14	37.8%
Total	717	107	14.9%

[a] Three coho adults were not measured at release.
[b] One recovery was not measured at release.

Table 8. Sex composition of Salmon River system coho adults in the disk tag application and spawning ground recovery samples, 1988-89.

	Application sample[a]			Spawning ground recovery sample[b]		
	Recovered	Not Recovered	Total	Disk tag or secondary mark	Unmarked	Total
Male	44.9%	38.7%	39.6%	44.9%	41.7%	42.0%
Female	55.1%	61.3%	60.4%	55.1%	58.3%	58.0%
Sample size	107	610	717	107	1,270	1,377

[a] Corrected for sex identification error.
[b] Excludes jacks.

Table 9. Escapement estimates, by sex and AFC status, for Salmon River coho salmon, 1988-89.

	Escapement estimates	95% confidence limit	
		Lower	Upper
Male	3,373	2,524	4,224
Female	5,779	4,435	7,126
Total	9,152	7,560	10,746
AFC[a] Adult	1,316	1,153	1,479

[a] Adipose fin clipped.

Table 10. Smolt release, adult escapement and survival to adult escapement of coded wire tagged 1984 and 1985 brood Salmon River coho salmon.

CWT Code	Brood year	Number released[a]	Spawning ground recoveries		Estimated AFC escapement	Percent survival to escapement
			Number	%		
02 38 38	84	2,811	4	2.1%	124[b]	4.4%[b]
02 38 39	84	2,736	4	2.1%	140[b]	5.1%[b]
02 43 10	85	20,022	158	82.3%	1,082	5.4%
No pin		-	26	13.5%	178	-

[a] Adjusted for long term CWT loss.
[b] Includes 1987-88 escapements of 97 (code 02 38 38) and 113 (code 02 38 39) (Schubert and Kalnin 1990).

Age, Length and Sex

The age and length of 245 coho salmon recovered on the spawning grounds is summarized by sex in Appendix 11. Sampled females were 98.0% age 3_2 and 2.0% age 4_3, while males were 96.9% age 3_2 and 3.1% age 4_3.

POH length of adult males and females recovered on the spawning grounds averaged 41.1 cm and 43.7 cm, respectively. NF length of adult males and females measured during disk tag application averaged 48.5 cm and 52.1 cm, respectively; however, these estimates may be biased due to sex identification error.

Females comprised 60.4% of the application sample, 58.0% of the census sample (Table 2) and 63.1% of the Petersen population estimate.

DISCUSSION

GENERAL

Juvenile Program

Relative to 1986, the 1987 juvenile program showed a marked increase in the number of coho smolts released with AFCs and CWTs (Schubert and Kalnin 1990). This reflected substantial improvements in trap integrity. The AFC incidence in subsequent adults increased from 3.4% in 1987-88 to 14.4% in 1988-89.

Adult Program

Relative to 1987-88, the 1988-89 total escapement declined by 23%, from 11,947 to 9,152; however, this decline does not reflect the true impact on subsequent production. While the adult male escapement declined by 50%, the female escapement increased by 11%.

The efficiency of 1988-89 field activities also declined relative to 1987-88. For example, both the proportion of the populations tagged and the proportion censused declined by approximately 50%. A series of freshets during 1988-89 hampered both the disk tag application and recovery components of the study. The efficiency of the former was also hampered by efforts in 1988-89 to apply tags by reach in proportion to estimated abundance. This required more effort to be expended in reaches other than Reach S1, the location of highest coho abundance.

ADULT CAPTURE TECHNIQUE

The 1987-88 study identified a potential concern that electroshocking stress may have influenced the subsequent catchability of disk tagged coho adults (Schubert and Kalnin 1990). A significant difference was noted in the spawning success of disk tagged and untagged females in both 1987-88 and 1988-89, with higher success in the latter. This suggests that capture stress influenced subsequent survival; however, we were unable to determine if behavioural change associated with reduced spawning success also influence catchability. Attempts should be made to evaluate this factor in future studies.

SAMPLING SELECTIVITY

A basic assumption underlying Petersen mark-recapture studies is that the population is sampled in a random or representative manner (Ricker 1975). In studies when non-representative sampling occurs, accurate results may still be achieved if one sample is representative (Robson 1969). In the present study, it was not possible to test for representativeness because the true populat-

Table 11. Results of statistical tests for bias in the 1988-89 Salmon River system escapement estimation study.

Test	Application Sample	Recovery Sample
Period	Bias for males only	No bias
Location	Bias towards reaches S1 and S2	No bias
Fish size	No bias	No bias
Fish sex	No bias	No bias

ion parameters were not known. Instead, we examined the samples for four biases: temporal, spatial, fish size and fish sex, as indicators of weaknesses in the study design. Significant biases were identified only in the application sample, which was biased with respect to period (males only) and location (Table 11). Because no biases were noted in the recovery sample, we concluded that it was unlikely that sampling selectivity resulted in a biased escapement estimate in 1988-89.

SUMMARY

1. The Salmon River (Langley) coho stock is one of a group of British Columbia stocks being monitored to evaluate responses to management actions by measuring, with known precision, annual escapement, marine survival, harvest distribution and exploitation rate.

2. Coded wire tags (CWT) were applied to emigrant smolts from April 24 to May 29, 1987. The smolts were captured at fence traps in the Salmon River and Coghlan Creek , the principal tributary. Tagged smolts were transported and released below the pumphouse at the river mouth.

3. A total of 20,022 coho smolts (adjusted for long term CWT loss) were released with CWTs and adipose fin clips. Size averaged 95.6 mm NF length and 9.6 g.

4. Adult spawners were enumerated by a mark-recapture study from November 2, 1988 to January 27, 1989. Coho adults were captured using an electroshocker and marked with Petersen disk tags and an operculum punch. The escapement was censused by the recovery of carcasses following spawning.

5. The 1988-89 coho adult escapement was estimated from a disk tag application sample of 717, a census sample of 1,377 and a recovery of 107 carcasses with disk tags or secondary marks. The estimated escapement was 9,152, of which 5,779 were females, 3,373 were males and 1,316 had adipose fin clips.

6. The estimated return to the spawning grounds of codes 02 38 38, 02 38 39 and 02 43 10 were 27, 27 and 1,082, respectively. Survival from smolt release to

spawning ground recovery was 5.4% for 1985 brood Salmon River coho. CWT loss averaged 13.5%.

7. The age composition of coho adults, measured from the census sample, was 98% age 3_2. Adult POH length averaged 41.1 cm for males and 43.7 cm for females.

8. Biases were identified in the application sample only. These sampling biases did not bias the final population estimate.

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APPENDICES

Appendix 1a. Daily fence trap catches in the Salmon River, 1987.

Date	Water temp. (C) a	Water level (M) a	Coho Smolts	Cutthroat Smolts	Cutthroat Pre-Smolts	Rainbow Smolts	Rainbow Pre-Smolts	Lamprey	Stickleback	Crayfish
22-Apr	-	-	0	0	0	0	0	0	0	0
23-Apr	-	-	0	0	0	0	0	0	0	0
24-Apr	9.0	-	67	99	0	0	0	3	0	0
25-Apr	-	-	5	12	0	2	0	0	1	0
26-Apr	8.5	7.55	0	0	0	0	0	0	0	0
27-Apr	11.0	7.55	0	0	0	0	0	0	0	0
28-Apr	12.0	7.52	2,272	15	78	0	2	3	0	0
29-Apr	11.0	7.51	753	35	88	1	0	1	1	1
30-Apr	12.0	7.52	2,719	245	295	8	0	2	0	0
01-May	11.0	8.05	743	285	351	10	0	0	0	1
02-May	10.5	8.25	464	143	131	1	0	1	0	0
03-May	9.5	8.05	154	65	75	0	0	0	0	0
04-May	12.0	7.78	117	21	32	0	0	0	0	0
05-May	11.0	7.74	0	0	1	0	0	0	0	0
06-May	11.0	7.60	932	127	54	1	0	2	0	0
07-May	12.0	7.68	1,655	201	60	0	0	0	0	1
08-May	12.5	7.52	1,243	258	66	1	0	2	1	1
09-May	13.0	7.51	1,017	236	99	0	0	3	1	0
10-May	12.0	7.48	479	47	63	0	0	0	1	0
11-May	13.0	7.50	240	9	3	0	0	1	0	0
12-May	12.0	7.63	968	287	12	3	0	0	0	0
13-May	11.5	7.63	458	156	83	0	0	0	0	1
14-May	12.0	7.64	298	132	30	0	0	0	1	0
15-May	11.0	7.65	367	262	155	0	0	1	0	0
16-May	-	7.60	79	37	3	0	0	3	0	0
17-May	-	7.75	3	10	0	0	0	0	0	0
18-May	10.5	7.52	31	39	23	0	0	0	0	0
19-May	10.0	7.51	62	42	23	0	0	0	0	0
20-May	9.0	7.47	201	90	44	0	0	2	0	0
21-May	10.0	7.48	17	2	5	0	0	5	1	1
22-May	11.0	7.48	10	8	5	0	0	0	0	0
23-May	13.0	7.48	83	86	58	0	0	1	0	0
24-May	-	-	36	93	15	0	0	4	0	0
25-May	11.0	7.46	39	47	27	0	0	1	0	2
26-May	12.0	7.46	19	42	39	0	0	3	1	0
27-May	12.0	7.45	2	19	38	0	0	1	0	0
28-May	11.0	7.48	0	10	13	0	0	1	0	0
29-May	11.5	7.48	19	12	31	0	0	0	0	0
30-May	11.0	7.68	20	32	106	0	1	2	1	1
31-May	9.5	8.92	-	-	-	-	-	-	-	-
01-Jun	10.0	7.64	-	-	-	-	-	-	-	-
Total	-	-	15,572	3,204	2,106	27	3	42	9	9

a. Recorded at 9:00 AM.

Appendix 1b. Daily fence trap catches in Coghlan Creek, 1987.

Date	Water temp. (C) a	Water level (M) a	Coho Smolts	Cutthroat Smolts	Cutthroat Pre-Smolts	Rainbow Smolts	Rainbow Pre-Smolts	Lamprey	Stickleback	Crayfish
22-Apr	-	-	150	17	0	8	0	0	0	0
23-Apr	9.0	1.18	117	21	0	3	0	0	0	0
24-Apr	9.0	1.17	279	65	0	2	0	0	0	0
25-Apr	7.0	-	7	7	0	0	0	0	0	0
26-Apr	-	-	1	0	0	0	0	0	0	1
27-Apr	9.0	1.14	517	44	0	2	0	0	0	2
28-Apr	11.0	1.13	188	6	0	0	0	0	0	0
29-Apr	10.0	1.10	94	0	3	0	0	0	0	0
30-Apr	12.0	1.14	306	2	4	0	0	0	0	0
01-May	10.5	1.60	565	52	14	0	0	0	0	0
02-May	9.5	1.52	144	31	12	0	0	0	0	0
03-May	9.5	1.48	98	12	19	0	0	0	0	0
04-May	10.5	1.30	56	14	2	0	0	0	0	0
05-May	10.0	1.26	594	15	9	0	0	0	1	0
06-May	10.0	1.20	903	21	10	0	0	0	0	0
07-May	10.5	1.17	746	36	9	1	0	0	1	1
08-May	11.0	1.16	1,127	43	17	0	0	0	0	0
09-May	11.0	1.12	479	63	18	0	0	0	0	1
10-May	10.5	1.11	62	4	3	0	0	1	0	0
11-May	13.0	1.12	72	0	4	0	0	0	0	0
12-May	11.0	1.32	558	219	15	0	0	0	0	0
13-May	11.0	1.18	302	3	8	0	0	0	0	0
14-May	11.0	1.30	172	132	30	0	0	1	0	0
15-May	10.5	1.23	165	8	2	0	0	1	0	0
16-May	-	-	10	47	0	0	0	1	0	0
17-May	-	1.15	159	27	0	0	0	1	0	0
18-May	10.0	1.13	23	3	0	0	0	1	0	0
19-May	9.0	1.12	143	7	2	0	0	0	0	0
20-May	8.5	1.10	13	6	0	0	0	0	0	0
21-May	9.0	1.09	37	3	1	0	0	1	0	1
22-May	10.0	1.07	30	2	0	0	0	1	0	1
23-May	12.0	1.09	13	4	0	0	0	0	0	1
24-May	-	1.10	12	0	0	0	0	2	0	0
25-May	10.0	1.09	18	10	3	0	0	0	0	1
26-May	11.0	1.08	0	0	0	0	0	0	0	1
27-May	11.0	1.08	120	10	23	0	0	0	0	2
28-May	11.0	1.18	64	25	14	0	0	5	0	1
29-May	10.5	1.10	103	32	18	0	0	2	0	0
30-May	10.5	1.48	29	75	24	0	0	0	2	1
31-May	10.0	2.52	-	-	-	-	-	-	-	-
01-Jun	10.0	1.72	-	-	-	-	-	-	-	-
Total	-	-	8,476	1,066	264	16	0	17	4	14

a. Recorded at 9:00 AM.

Appendix 2a. Salmon River coded wire tagging results (code 02 43 10), 1987.

Tagging date	Maximum holding time (days)	Pre-tagging mort-ality	Released without tagging	Total number marked	24 hour CWT rejection		AFC only	Post tagging mortality		Total released with CWTs c
					N a	%		Immediate	24 hour b	
24-Apr	2	9	0	67	127	0.0	0	0	0	58
27-Apr	2	2	0	5	166	3.6	0	0	0	4
28-Apr	0	0	3	1,848	199	1.0	0	2	0	1,596
29-Apr	0	0	1	1,171	131	0.0	1	1	0	1,011
30-Apr	0	0	1	2,412	226	4.9	3	1	0	2,082
01-May	0	3	9	767	252	1.2	3	27	0	637
02-May	0	0	0	457	201	4.0	1	10	0	386
05-May	3	0	2	266	248	0.0	1	2	1	227
06-May	0	1	1	830	212	0.5	1	0	0	717
07-May	0	0	1	1,631	275	1.5	3	11	0	1,398
08-May	0	0	1	1,238	373	0.0	0	17	0	1,056
09-May	0	0	1	1,017	323	0.3	0	1	0	878
11-May	1	0	2	719	354	0.0	0	0	0	622
12-May	0	0	4	923	313	0.0	0	5	0	794
14-May	1	0	2	745	390	1.0	1	0	0	643
15-May	0	0	0	368	163	0.0	0	5	0	314
19-May	4	0	0	131	452	0.0	0	0	0	113
22-May	3	0	2	218	297	0.3	0	0	0	188
26-May	4	0	1	173	213	0.0	0	0	1	149
29-May	3	0	0	29	297	0.0	0	0	0	25
Total	(Mean)	15	31	15,015	5,212	0.92	14	82	2	12,897

a. Sample size held to assess tag loss.

b. Based on mortality rate observed in QCD subsample expanded to entire tag lot.

c. Adjusted for long term CWT loss (see text).

Appendix 2b. Coghlan Creek coded wire tagging results (code 02 43 10), 1987.

Tagging date	Maximum holding time (days)	Pre-tagging mort-ality	Released without tagging	Total number marked	24 hour CWT rejection		Post tagging mortality			Total released with CWTs
					N a	%	AFC only	Immediate	24 hour b	
24-Apr	2	9	0	376	127	0.0	0	0	0	325
27-Apr	2	2	0	500	166	3.6	0	2	3	428
28-Apr	0	0	3	188	199	1.0	0	0	0	163
29-Apr	0	0	1	94	131	0.0	0	1	0	80
30-Apr	0	0	1	306	226	4.9	1	0	0	264
01-May	0	3	9	565	252	1.2	2	12	0	476
02-May	0	0	0	140	201	4.0	0	6	0	116
05-May	3	0	2	748	248	0.0	1	4	3	640
06-May	0	1	1	998	212	0.5	1	0	0	862
07-May	0	0	1	769	275	1.5	1	5	0	660
08-May	0	0	1	1,127	373	0.0	0	16	0	961
09-May	0	0	1	479	323	0.3	1	0	0	413
11-May	1	0	2	134	354	0.0	0	0	0	116
12-May	0	0	4	505	313	0.0	0	1	0	436
14-May	1	0	2	474	390	1.0	0	0	0	410
15-May	0	0	0	165	163	0.0	0	3	0	140
19-May	4	0	0	335	452	0.0	0	0	0	290
22-May	3	0	2	80	297	0.3	0	0	1	68
26-May	4	0	1	43	213	0.0	0	0	0	37
29-May	3	0	0	280	297	0.0	1	0	0	241
Total	(Mean)	15	31	8,306	5,212	0.92	8	50	7	7,125

a. Sample size held to assess tag loss.

b. Based on mortality rate observed in QCD subsample expanded to entire tag lot.

c. Adjusted for long term CWT loss (see text).

Appendix 3. Incidence of anomalies encountered while coded wire tagging wild Salmon River system coho salmon smolts, 1987.

Location	Number Inspected	Fog eye	Neascus	Fin rot	General damage
Salmon River	15,015	1,018	17	13	3
	%	6.78	0.11	0.09	0.02
Coghlan Creek	8,306	508	12	6	2
	%	6.12	0.14	0.07	0.02
Total	23,321	1,526	29	19	5
	% Total	6.54	0.12	0.08	0.02

Appendix 4. Mean length and weight of coho smolts in the Salmon River system, 1987.

Location	Sample date	Sample size	Nose-Fork length (mm) Mean	Nose-Fork length (mm) Standard deviation	Mean wet weight (g)
Salmon River	28-Apr	50	98.0	11.0	10.1
	02-May	50	102.0	13.8	11.8
	05-May	50	93.4	9.2	8.6
	08-May	50	95.6	7.4	9.3
	12-May	50	93.1	7.8	8.8
	15-May	50	91.7	7.3	8.4
	19-May	50	95.2	8.6	9.1
	22-May	50	89.8	4.8	8.2
	26-May	50	90.8	8.7	8.2
	29-May	21	88.4	7.1	6.6
	Total	471	97.0 a	-	10.0 a
Coghlan Creek	28-Apr	50	99.0	10.4	10.1
	02-May	50	95.4	11.1	9.3
	05-May	50	92.5	8.0	8.8
	08-May	50	94.2	11.4	9.7
	12-May	50	86.9	6.0	7.4
	15-May	50	89.8	8.1	7.9
	19-May	50	89.7	7.1	7.8
	22-May	50	86.5	6.9	7.0
	26-May	45	85.1	7.4	6.5
	29-May	50	88.4	6.8	7.4
	Total	495	93.1 a	-	9.0
Total	-		95.6 a	-	9.6

a. Weighted by proportion of smolt migration in time periods.

Appendix 5a. Coho adult disk tag application results in the Salmon River, 1988-89. a

		Adipose present			Adipose absent			Total		
Date	Reach b	Male	Female	Total	Male	Female	Total	Male	Female	Total
02-Nov	S1	6	10	16	4	5	9	10	15	25
	S3	3	3	6	0	1	1	3	4	7
04-Nov	S4	1	1	2	1	0	1	2	1	3
07-Nov	S1	9	28	37	5	2	7	14	30	44
09-Nov	S1	11	15	26	3	3	6	14	18	32
	S4	18	21	39	12	12	24	30	33	63
10-Nov	S1	1	3	4	0	1	1	1	4	5
	S2	2	5	7	0	0	0	2	5	7
	S3	0	1	1	0	0	0	0	1	1
14-Nov	S1	10	25	35	4	3	7	14	28	42
	S4	12	16	28	9	11	20	21	27	48
16-Nov	S1	23	38	61	9	12	21	32	50	82
18-Nov	S2	2	2	4	0	0	0	2	2	4
	S3	16	18	34	2	4	6	18	22	40
	S4	10	9	19	7	15	22	17	24	41
30-Nov	S1	11	22	33	2	6	8	13	28	41
02-Dec	S1	0	1	1	1	0	1	1	1	2
	S3	0	3	3	0	1	1	0	4	4
	S4	6	6	12	3	1	4	9	7	16
09-Dec	S4	9	3	12	2	7	9	11	10	21
16-Dec	S4	5	1	6	2	0	2	7	1	8
	S5	3	6	9	3	4	7	6	10	16
21-Dec	S1	8	11	19	1	3	4	9	14	23
06-Jan	S1	9	6	15	0	3	3	9	9	18
	S2	1	1	2	0	0	0	1	1	2
Total	S1	88	159	247	29	38	67	117	197	314
	S2	5	8	13	0	0	0	5	8	13
	S3	19	25	44	2	6	8	21	31	52
	S4	61	57	118	36	46	82	97	103	200
	S5	3	6	9	3	4	7	6	10	16
	Total	176	255	431	70	94	164	246	349	595

a. Not corrected for sex identification errors.

b. Salmon River Reaches: S1 - below Coghlan Creek.
S2 - Coghlan Creek to 64 Ave.
S3 - 64 Ave. to 56 Ave.
S4 - 56 Ave. to 248 St.
S5 - 248 St. to 256 St.

Appendix 5b. Coho adult disk tag application results in Coghlan Creek, 1988-89. a

		Adipose present			Adipose absent			Total		
Date	Reach b	Male	Female	Total	Male	Female	Total	Male	Female	Total
04-Nov	C1	6	2	8	1	1	2	7	3	10
07-Nov	C1	9	16	25	2	0	2	11	16	27
14-Nov	C1	9	11	20	1	1	2	10	12	22
18-Nov	C1	4	9	13	2	0	2	6	9	15
02-Dec	C1	9	15	24	1	0	1	10	15	25
07-Dec	C1	4	1	5	0	1	1	4	2	6
21-Dec	C3	4	5	9	0	0	0	4	5	9
	C5	6	2	8	0	0	0	6	2	8
Total	C1	41	54	95	7	3	10	48	57	105
	C3	4	5	9	0	0	0	4	5	9
	C5	6	2	8	0	0	0	6	2	8
	Total	51	61	112	7	3	10	58	64	122

a. Not corrected for sex identification errors.
b. Coghlan Creek reaches: C1 - Salmon River to Hwy 1.
C2 - Hwy 1 to 248 St.
C3 - 248 St. to 64 Ave.
C4 - 64 Ave. to 256 St.
C5 - Above 256 St.

Appendix 6. Disk tag recoveries in the Salmon River system, by application and recovery date and location, 1988-89

Application sample					Recovery sample					
Date	Reach c	NF length (cm)	Sex	Adipose fin	Date	Reach	POH length (cm)	Sex		Time out (days)
02-Nov	S1	53.5	F	p	11-Jan	C1	- b	F		70
04-Nov	C1	53.7	F	a	23-Jan	SJ	- b	F		80
04-Nov	S4	38.5	M	a	28-Nov	S3	29.4	M		24
07-Nov	C1	55.0	F	p	11-Jan	S1	- b	F		65
07-Nov	C1	52.3	F	p	09-Dec	C1	43.0	F		32
07-Nov	C1	49.0	F	p	09-Dec	C1	40.4	F		32
07-Nov	C1	53.0	F	p	19-Dec	C1	41.0	F		42
07-Nov	C1	48.5	F	p	19-Dec	C1	- b	F		42
07-Nov	S1	54.4	F	p	19-Dec	S1	- b	F		42
07-Nov	S1	51.9	F	p	09-Dec	S2	42.3	F		32
07-Nov	S1	50.8	M	a	14-Nov	C1	37.5	M		7
07-Nov	S1	48.0	M	p	16-Nov	S1	38.8	M		9
07-Nov	S1	43.0	M	a	16-Nov	S1	34.0	M		9
09-Nov	S1	48.0	F	p	25-Nov	S1	38.4	F		16
09-Nov	S1	48.7	M	p	09-Dec	S1	40.4	M		30
09-Nov	S1	60.5	F	a	06-Jan	S1	- b	F		58
09-Nov	S4	61.0	F	p	28-Nov	S3	50.8	F		19
09-Nov	S4	56.0	M	p	09-Dec	S3	43.8	M		30
09-Nov	S4	42.0	M	p	10-Nov	S4	33.2	M		1
09-Nov	S4	50.5	M	p	05-Dec	S4	38.7	M		26
09-Nov	S4	53.5	F	p	30-Nov	S4	45.4	F		21
09-Nov	S4	57.2	F	a	19-Dec	S1	44.5	F		40
09-Nov	S4	46.3	F	a	02-Dec	S4	37.0	F		23
09-Nov	S4	48.1	F	p	05-Dec	S4	39.1	F		26
10-Nov	S1	63.8	F	a	19-Dec	C1	49.6	F		39
10-Nov	S2	54.0	M	p	28-Nov	S3	42.3	M		18
14-Nov	C1	54.1	F	p	19-Dec	C1	42.7	F		35
14-Nov	C1	54.2	F	p	16-Dec	C1	39.0	M	a	32
14-Nov	S1	51.4	F	p	16-Nov	S1	40.0	F		2
14-Nov	S1	53.2	M	p	06-Jan	C1	41.8	F	a	53
14-Nov	S1	61.0	F	p	19-Dec	C1	48.9	F		35
14-Nov	S1	66.1	F	p	16-Nov	S1	54.2	F		2
14-Nov	S1	52.8	M	a	19-Dec	S1	-b	M		35
14-Nov	S1	54.8	M	a	19-Dec	S1	43.1	M		35
14-Nov	S1	48.2	M	p	16-Nov	S1	40.7	M		2
14-Nov	S1	46.5	F	p	16-Nov	S1	33.8	F		2
14-Nov	S4	63.0	M	p	18-Nov	S4	51.8	M		4
14-Nov	S4	50.0	M	p	16-Dec	S3	- b	M		32
14-Nov	S4	48.0	M	a	29-Dec	S3	- b	M		45
14-Nov	S4	45.0	M	a	30-Nov	S4	36.5	M		16
14-Nov	S4	48.0	F	a	20-Jan	S5	37.2	F		67
14-Nov	S4	53.5	M	a	02-Dec	S4	40.8	M		18
14-Nov	S4	60.5	M	a	09-Dec	S3	48.8	M		25
14-Nov	S4	49.2	F	p	23-Jan	S2	- b	F		70
16-Nov	S1	64.6	F	p	28-Nov	S1	51.2	F		12
16-Nov	S1	42.0	M	p	20-Jan	C1	- b	M		65
16-Nov	S1	56.0	F	a	19-Dec	C1	45.3	F		33

Appendix 6. Disk tag recoveries in the Salmon River system, by application and recovery date and location, 1988-89

Application sample					Recovery sample					
Date	Reach c	NF length (cm)	Sex	Adipose fin	Date	Reach	POH length (cm)	Sex		Time out (days)
16-Nov	S1	48.0	M	p	19-Dec	C1	37.9	M		33
16-Nov	S1	55.5	M	p	19-Dec	S1	43.1	M		33
16-Nov	S1	51.6	F	p	16-Dec	S1	42.6	F		30
16-Nov	S1	49.8	M	p	25-Nov	S1	39.6	M		9
16-Nov	S1	52.4	F	p	09-Dec	S1	41.7	F		23
16-Nov	S1	59.7	M	p	20-Jan	C1	- b	M		65
16-Nov	S1	47.5	M	p	19-Dec	S1	48.8	M		33
16-Nov	S1	49.7	F	p	19-Dec	C1	- b	F		33
16-Nov	S1	46.5	M	p	19-Dec	C1	37.5	M		33
16-Nov	S1	49.0	M	p	25-Nov	S1	39.8	M		9
18-Nov	S3	50.0	M	p	30-Nov	S1	39.6	M		12
18-Nov	S3	48.0	F	p	06-Jan	S1	39.3	F		49
18-Nov	S3	49.8	F	p	05-Jan	S4	38.7	M	a	48
18-Nov	S3		F	p	16-Dec	S1	41.4	F		28
18-Nov	S4	54.0	M	p	11-Jan	S3	- b	M		54
18-Nov	S4	52.5	F	a	29-Dec	S3	38.2	F		41
18-Nov	S4	38.0	M	a	19-Dec	S4	30.5	F	a	31
18-Nov	S4	50.4	F	p	19-Dec	S3	- b	F		31
18-Nov	S4	48.0	M	p	28-Nov	S3	36.5	M		10
18-Nov	S4	52.0	F	p	30-Nov	S4	43.2	F		12
30-Nov	S1	66.8	F	p	16-Dec	S1	52.3	F		16
30-Nov	S1	54.3	M	p	19-Dec	C1	42.8	M		19
30-Nov	S1	52.0	F	p	19-Dec	S1	39.5	F		19
30-Nov	S1	48.5	F	p	23-Jan	S1	- b	F		54
30-Nov	S1	50.6	M	p	23-Jan	S1	29.4	F	a	54
30-Nov	S1	63.2	F	a	29-Dec	C3	51.2	M	a	29
02-Dec	C1	46.0	M	p	16-Dec	C1	36.8	M		14
02-Dec	C1	60.5	F	p	19-Dec	C1	47.6	F		17
02-Dec	C1	48.2	M	a	06-Jan	C1	38.4	M		35
02-Dec	C1	43.0	F	p	19-Dec	C1	35.8	M	a	17
02-Dec	S1	48.3	M	p	19-Dec	S1	39.0	F	a	17
02-Dec	S3	56.4	F	p	06-Jan	S1	46.2	F		35
02-Dec	S3	49.0	F	p	09-Dec	S3	41.2	F		7
02-Dec	S4	57.6	F	p	09-Dec	S3	50.1	F		7
02-Dec	S4	50.0	F	p	06-Jan	S3	41.2	F		35
02-Dec	S4	59.5	M	p	29-Dec	S3	- b	M		27
02-Dec	S4	42.6	M	p	19-Dec	S3	34.2	M		17
02-Dec	S4	56.4	M	p	16-Dec	S1	52.8	F	a	14
07-Dec	C1	50.8	M	p	19-Dec	S1	40.8	M		12
07-Dec	C1	49.8	F	p	05-Jan	S4	48.9	F		29
07-Dec	C1	52.0	M	a	20-Jan	C1	- b	M		44
09-Dec	S4	61.5	F	a	19-Dec	S4	49.2	F		10
09-Dec	S4	49.0	F	a	06-Jan	S2	41.1	F		28
09-Dec	S4	53.2	M	p	11-Jan	S3	43.5	M		33
09-Dec	S4	48.0	M	p	11-Jan	S1	37.8	M		33
16-Dec	S4	47.5	M	a	11-Jan	S3	36.8	M		26
16-Dec	S4	61.0	F	p	06-Jan	S1	46.8	F		21

Appendix 6. Disk tag recoveries in the Salmon River system, by application and recovery date and location, 1988-89

Application sample					Recovery sample					
Date	Reach c	NF length (cm)	Sex	Adipose fin	Date	Reach	POH length (cm)	Sex		Time out (days)
16-Dec	S5	55.5	F	p	05-Jan	S5	44.6	F		20
16-Dec	S5	51.6	M	p	28-Dec	S4	42.6	M		12
21-Dec	C3	50.0	F	p	20-Jan	C2	- b	F		30
21-Dec	C3	50.0	M	p	06-Jan	C2	40.8	F	a	16
21-Dec	C5	60.3	F	p	28-Dec	C5	50.8	F		7
21-Dec	C5	53.5	M	p	28-Dec	C4	43.4	M		7
21-Dec	C5	53.2	F	p	28-Dec	C4	44.6	F		7
21-Dec	S1	49.9	F	p	06-Jan	S1	40.4	F		16
21-Dec	S1	55.6	M	p	29-Dec	S1	- b	M		8
21-Dec	S1	57.3	M	p	20-Jan	C1	44.7	M		30
21-Dec	S1	51.5	F	p	23-Jan	S1	43.6	F		33
21-Dec	S1	53.7	M	p	29-Dec	S1	42.1	M		8
06-Jan	S1	47.5	F	a	23-Jan	S1	39.7	F		17

Females initially identified as male: 6 (10.2%)
Males initially identified as female: 4 (8.3%)

Mean: 27.6
Maximum: 80
Minimum: 1

POHL and FL regressions:

-Adult Males: POHL = 0.81 FL - .95
NF = 1.14 POHL + 5.00

-Adult Females: POHL = .76 FL + 1.04
NF = 1.10 POHL + 5.74

a. Incorrect sex identification during disk tag application.
b. POH not available due to decomposition or partial predation.
c. Salmon River: S1 - below Coghlan Cr.
S2 - Coghlan Cr to 64 Ave.
S3 - 64 Ave. to 56 Ave.
S4 - 56 Ave. to 248 St.
S5 - 248 St. to 256 St.

Coghlan Creek: C1 - Salmon River to Hwy 1.
C2 - Hwy. 1 to 248 ST.
C3 - 248 ST. to 64 Ave.
C4 - 64 Ave. to 256 ST.
C5 - Above 256 St.

Appendix 7a. Summary of live observations and dead counts of coho salmon in the Salmon River, 1988-89.

Date	Reach	Live count	Dead count							Disk tag and secondary mark	
			Adipose fin present			Adipose fin absent			Adult total		
			Male	Female	Jack	Male	Female	Jack		Male	Female
10-Nov	S4	0	1	0	0	0	0	0	1	1	0
16-Nov	S1	11	2	5	0	1	1	0	9	3	3
18-Nov	S3	19	0	0	0	0	0	0	0	0	0
	S4	0	1	3	0	1	1	0	6	1	0
25-Nov	S1	7	3	7	0	0	0	0	10	2	1
	S2	1	0	0	0	0	0	0	0	0	0
28-Nov	S1	13	2	2	0	0	1	0	5	0	1
	S2	0	1	1	0	0	0	0	2	0	0
	S3	4	3	4	0	2	2	0	11	3	1
30-Nov	S1	27	1	1	0	0	0	0	2	1	0
	S4	50	12	18	1	7	4	0	41	1	2
	S5	1	5	13	1	0	7	0	25	0	0
02-Dec	S3	19	0	0	0	1	0	0	1	0	0
	S4	13	0	0	0	2	1	0	3	1	1
05-Dec	S4	10	4	11	2	1	6	0	22	1	1
	S5	5	6	5	0	0	5	0	16	0	0
09-Dec	S1	12	3	6	0	2	2	0	13	1	1
	S2	6	0	1	1	0	0	0	1	0	1
	S3	25	9	10	0	2	3	0	24	2	2
	S4	4	1	1	0	2	0	0	4	0	0
14-Dec	S4	32	5	8	0	2	5	0	20	0	0
	S5	9	1	6	0	0	3	0	10	0	0
16-Dec	S1	7	2	12	0	1	1	0	16	0	4
	S2	0	0	0	0	0	0	0	0	0	0
	S3	7	10	4	0	1	1	0	16	1	0
	S4	12	0	0	0	1	0	0	1	0	0
	S4	4	0	0	0	1	0	0	1	0	0
	S5	5	5	1	0	0	0	0	6	0	0
19-Dec	S1	1	7	4	0	0	2	0	13	4	4
	S2	0	1	0	0	0	0	0	1	0	0
	S3	1	10	18	0	1	2	0	31	1	1
	S4	3	6	8	1	3	4	0	21	0	2
	S5	4	4	9	0	2	1	0	16	0	0
21-Dec	S1	3	0	1	0	0	0	0	1	0	0
28-Dec	S4	6	21	31	0	6	11	1	69	1	0
	S5	3	12	13	0	2	4	0	31	0	0
29-Dec	S1	1	10	7	0	2	1	0	20	3	0
	S2	2	0	2	0	0	1	0	3	0	0
	S3	3	11	11	0	2	2	0	26	2	1
	S4	0	0	2	0	0	2	0	4	0	0
05-Jan	S5	0	5	10	0	1	3	0	19	0	1
	S4	5	12	15	0	3	3	0	33	1	1
	S4	16	0	2	0	0	0	0	2	0	0
06-Jan	S1	5	3	18	0	0	1	0	22	0	5
	S2	0	1	3	0	1	0	0	5	0	1
	S3	4	5	12	0	1	0	0	18	0	1
09-Jan	S4	0	0	0	0	0	0	0	0	0	0

Appendix 7a. Summary of live observations and dead counts of coho salmon in the Salmon River, 1988-89.

Date	Reach	Live count	Dead count							Disk tag and secondary mark	
			Adipose fin present			Adipose fin absent			Adult total		
			Male	Female	Jack	Male	Female	Jack		Male	Female
	S4	2	2	7	0	0	2	0	11	0	0
	S5	1	1	2	0	0	0	0	3	0	0
11-Jan	S1	5	4	3	0	0	0	0	7	1	1
	S2	0	0	1	0	0	0	0	1	0	0
	S3	4	5	0	0	1	1	0	7	3	0
20-Jan	S4	0	2	8	0	0	0	0	10	0	0
	S5	1	0	1	0	1	1	0	3	0	1
23-Jan	S1	0	6	12	0	0	1	0	19	0	5
	S2	0	0	1	0	0	0	0	1	0	1
	S3	2	1	4	0	1	1	0	7	0	0
26-Jan	S4	0	4	3	0	0	0	0	7	0	0
	S5	0	3	2	0	0	0	0	5	0	0
27-Jan	S1	2	4	3	0	0	0	0	7	0	0
	S2	2	0	0	0	0	1	0	1	0	0
	S3	0	0	0	0	0	0	0	0	0	0
Total	S1	-	47	81	0	6	10	0	144	15	25
	S2	-	3	9	1	1	2	0	15	0	3
	S3	-	54	63	0	12	12	0	141	12	6
	S4	-	71	117	4	29	39	1	256	7	7
	S5	-	42	62	1	6	24	0	134	0	2
Totals		-	217	332	6	54	87	1	690	34	43

Appendix 7b. Summary of live observations and dead counts of coho salmon in Coghlan Creek, 1988-89.

Date	Reach	Live Count	Dead count							Disk tag and secondary mark	
			Adipose fin present			Adipose fin absent			Adult total		
			Male	Female	Jack	Male	Female	Jack		Male	Female
14-Nov	C1	10	0	1	1	1	0	0	2	1	0
18-Nov	C1	8	2	1	0	1	0	0	4	0	0
28-Nov	C1	6	2	12	0	0	0	0	14	0	0
	C2	17	7	6	0	1	2	0	16	0	0
	C3	6	1	11	0	0	1	0	13	0	0
	C4	10	6	6	1	1	0	0	13	0	0
	C5	2	7	6	0	1	1	0	15	0	0
02-Dec	C1	16	1	1	0	0	0	0	2	0	0
05-Dec	C3	8	11	5	0	1	1	0	18	0	0
	C4	6	4	4	0	0	1	0	9	0	0
	C5	12	1	3	0	0	1	0	5	0	0
07-Dec	C1	31	0	4	0	0	0	0	4	0	0
09-Dec	C1	23	6	6	0	0	1	0	13	0	2
	C2	5	4	6	0	2	0	0	12	0	0
14-Dec	C3	25	8	17	0	1	1	0	27	0	0
	C4	4	5	9	0	1	4	0	19	0	0
	C5	7	2	2	0	0	1	0	5	0	0
16-Dec	C1	27	2	0	0	0	2	0	4	2	0
	C2	21	10	14	0	1	2	0	27	0	0
19-Dec	C1	14	12	12	0	1	0	0	25	4	8
	C2	9	7	14	0	0	0	0	21	0	0
	C3	5	7	5	0	0	1	0	13	0	0
	C4	8	9	7	0	0	1	0	17	0	0
21-Dec	C2	0	0	0	0	0	1	0	1	0	0
	C3	0	1	0	0	0	0	0	1	0	0
	C5	9	5	4	0	3	0	0	12	0	0
28-Dec	C4	8	15	11	0	5	5	0	36	1	1
	C5	2	4	7	0	0	0	0	11	0	1
29-Dec	C3	2	5	10	0	2	0	0	17	1	0
02-Jan	C1	4	5	4	0	0	0	0	9	0	0
05-Jan	C3	1	16	9	0	0	0	0	25	0	0
	C4	4	15	20	0	1	1	0	37	0	0
	C5	13	3	3	0	1	0	0	7	0	0
06-Jan	C1	12	32	25	0	0	0	0	57	1	1
	C2	8	15	21	0	0	0	0	36	0	1
09-Jan	C5	1	0	0	0	0	0	0	0	0	0
11-Jan	C1	3	6	21	0	0	0	0	27	0	1
	C2	2	1	3	0	0	0	0	4	0	0
	C3	0	4	5	0	0	0	0	9	0	0
	C4	0	5	4	0	0	0	0	9	0	0
20-Jan	C1	5	9	15	0	2	0	0	26	4	0
	C2	4	3	10	0	1	0	0	14	0	1
	C3	5	6	5	0	1	0	0	12	0	0
	C4	5	6	10	0	0	0	0	16	0	0
	C5	1	0	1	0	0	0	0	1	0	0
26-Jan	C2	1	2	4	0	0	0	0	6	0	0
	C3	0	2	1	0	0	1	0	4	0	0

Appendix 7b. Summary of live observations and dead counts of coho salmon in Coghlan Creek, 1988-89.

Date	Reach	Live Count	Dead count							Disk tag and secondary mark	
			Adipose fin present			Adipose fin absent			Adult total		
			Male	Female	Jack	Male	Female	Jack		Male	Female
	C4	5	5	5	0	0	1	0	11	0	0
	C5	1	1	0	0	0	0	0	1	0	0
Total	C1	-	77	102	1	5	3	0	187	12	12
	C2	-	49	78	0	5	5	0	137	0	2
	C3	-	61	68	0	5	5	0	139	1	0
	C4	-	70	76	1	8	13	0	167	1	1
	C5	-	23	26	0	5	3	0	57	0	1
Total		-	280	350	2	28	29	0	687	14	16

Appendix 8. Spawning success of female coho adult spawning ground recoveries, 1988-89.

		Percent spawned			
		0%	50%	100%	Weighted mean
Disk tag or secondary mark	Number	4	7	39	50
	Percent	8.0%	14.0%	78.0%	85.0%
Unmarked	Number	4	4	147	155
	Percent	2.6%	2.6%	94.8%	96.1%
Total	Number	8	11	186	205
	Percent	3.9%	5.4%	90.7%	93.4%

Appendix 9. Observed and estimated coho adult escapement, by CWT code, in the Salmon River system, 1988-89.

		CWT Code					
	Total	02 38 38	02 38 39	02 39 50 c	02 43 10	No CWT	CWT lost
Estimated AFC escapement	1,316 a	-	-	-	-	-	-
No. AFCs recovered	198	-	-	-	-	-	-
Observed CWT codes	193 b	4	4	1	158	26	-
Estimated escapement by code	-	27	27	1	1,082	178	-

a. Includes 1 AFC from Legace Creek which has not been expanded.
b. Excludes 5 recovered without heads.
c. Legace Creek coho, Inch Creek Hatchery.

Appendix 10. Incidence of CWT loss by carcass condition and eye status in AFC coho adults carcasses in the Salmon River system, 1988-89.

Group	Sample size a	CWT absent	CWT loss (%)
Condition 1	48	5	10.4
Condition 2	98	11	11.2
Condition 3	41	9	22.0
Condition 4	6	0	0.0
Eyes present	164	22	13.4
Eyes absent	29	4	13.8

a. Excludes 5 AFCs recovered with no head.

Appendix 11. Mean length, by sex and age, of Salmon River system coho spawners, 1988-89.

Sample	Age	Sex	Sample Size	Percent	Length: Mean (cm)	Length: Standard deviation	Length: Range (cm)
Application sample a, b	-	Male	302	42.3%	48.5	6.8	30.0 - 65.8
		Female	412	57.7%	52.1	4.6	37.7 - 68.4
Recovery sample c	3/2	Male	95	38.8%	41.1	4.6	29.4 - 53.2
		Female	144	58.8%	43.8	4.4	30.5 - 55.0
	4/3	Male	3	1.2%	41.2	4.7	35.2 - 46.8
		Female	3	1.2%	39.4	0.2	39.1 - 39.4
	Total	Male	98	40.0%	41.1	4.6	29.4 - 53.2
		Female	147	60.0%	43.7	4.4	30.5 - 55.0

a. Not adjusted for sex identification errors.
b. NF length.
c. POH length; excludes regenerate scale samples.